Perceiving social cohesion: Movement synchrony and task demands both matter.

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ABSTRACT

Previous research has shown that interpersonal synchrony is associated with a number of prosocial effects. We investigated the respective roles of behavioural synchrony and perceived task demands on perceptions of cohesion by performing two experiments in which participants viewed pairs of point-light figures engaging in four coordinated behaviours. Behaviours were seen twice, once in perfect in-phase synchrony and once with synchrony manipulated (phase-shift: 180° in Experiment 1 and 45°, 90°, 270° and 315° in Experiment 2). Dyads were rated on perceived exertion and perceived social cohesion. Results indicate that in-phase synchrony is associated with higher levels of perceived cohesion and that perceived exertion is a good predictor of cohesion ratings. Two interactions suggest that the effect is not purely perceptual and that participants observing coordinated movement also make inferences about the intentions of those observed. Results are discussed and future directions suggested.

Introduction

Interpersonal synchrony is something that is observed in all human cultures, from military display marching to intricate dancing (Reddish, Fischer, & Bulbulia, 2013), and people all over the world seem to intuitively understand that behavioural synchrony is somehow meaningful (Launay, Tarr, & Dunbar, 2016). Some researchers have deemed behavioural synchrony so important as a social act that they argue for it to be considered a fundamental component of human social life (Launay et al 2016; Marsh, Richardson, & Schmidt, 2009). In this paper we explore how viewing minimalist representations depicting the movement of two individuals can influence judgments about the social cohesion that exists between the depicted pair.

Perceived cohesion, synchrony and task demands

The synchronisation of actions by individuals has been found to have a number of consequences for both psychological function and behaviour (for a recent review and meta-analysis see Mogan, Fischer, & Bulbulia, 2017). For example, behavioural synchrony has been found to be associated with elevated trust (Launay, Dean, & Bailes, 2013), cooperation (Wiltermuth & Heath, 2009) and liking (Launay, Dean, & Bailes, 2014). The synchronisation of behaviour by independent organisms likely involves a number of psychological and physiological mechanisms. Lang, Bahna, Shaver, Reddis and Xygalatas (2017), for example, report data showing that the elevated prosocial effects of engaging in synchronous actions are a consequence of sociocognitive mechanisms linked to assessing the extent of self-other overlap and successful cooperation as well as the activation of the endogenous opioid system (see also Keller, Novembre, & Hove, 2014; Tarr, Launay, & Dunbar, 2014). Broadly, it can be said that when independent biological agents engage in synchronous behaviours, this is often indicative of some non-trivial connection between those involved. Much of the research into behavioural synchrony has been conducted from a first-person perspective and has largely confirmed the social bonding effect that engaging in such acts has (Mogan et al, 2017).

Researchers have also started to investigate the effects of behavioural synchrony from a third-person perspective. Given that synchronising behaviour often requires effort, witnessing such an activity should provide perceivers with a potent cue as to the relationship that exists between those observed engaging in it (Lakens & Stel, 2011). This approach has its roots in the Gestalt psychologists' attempts to articulate how collections of individual parts come to be seen as whole entities. Donald Campbell (1958), for example, famously described some of the core principles by which collections of component parts come to be seen as belonging to a singular unit, one of which was the principle of 'common fate': "elements that move together in the same direction, and otherwise in successive temporal observations share a 'common fate' are more likely to be perceived as parts of the same organization" (p. 18). Campbell's original formulations have now been adapted by psychologists interested in understanding how we perceive collections of individuals as groups (see e.g. Hamilton, 2007), with Phillips, Weisbuch, and Ambady (2014) explicitly arguing for the existence of processing mechanisms unique to group perception.

Research suggests two general factors that contribute to how collections of individuals are perceived: (1) the physical characteristics of the individual parts that make up the group, and (2) the behaviour of those parts when they are together (Ip, Chiu, & Wan, 2006). When collections of individuals closely coordinate their actions they are seen to be cohesive because the close coordination of actions suggests to the perceiver a degree of socioemotional connectedness that allows for such intricate coordination to take place (Marsh et al, 2009). This would suggest that perceptions of social closeness should closely track perceived behavioural synchrony. Miles, Nind, and Macrae (2009) report that the highest levels of perceived rapport between walking dyads were when the phase relationship between the strides of the walkers was either "in-phase" (i.e. were the actions were perfectly synchronised) or "anti-phase" (where the actions of each individual are simultaneously at opposite points of the movement cycle; known variously as a 180° .5 or 50% phase-shift). Both in-phase and anti-phase synchrony are stable modes of coordination, although in-phase synchrony is generally considered to be relatively more stable (see Haken, Kelso & Bunz, 1985; see also Macrae, Duffy, Miles, & Lawrence, 2008, for evidence of the primacy of in-phase synchrony over anti-phase synchrony on measures of person perception, and see Sullivan, Rickers, & Gammage, 2014, for data suggesting that the release of endorphins, indexed by measuring pain-thresholds, is affected more by in-phase activity than by anti-phase activity). Similarly, Lakens (2010) found across multiple studies that dyads displaying synchronous movements were rated as being higher in ‘entitativity’ (the degree to which individuals are seen as a discrete social unit) compared to dyads displaying non-identical movements. These findings were extended by Lakens & Stel (2011) who report that witnessing synchronised movement also influences attributions of rapport, and that judgments of both rapport and entitativity were mediated by whether or not the observer believed the synchronised act to have emerged spontaneously or as a result of explicit instruction. These findings led the authors to suggest that the effects of movement synchrony on social judgments are not purely perceptual, concluding that “when people see individuals move in synchrony, they draw inferences about the shared psychological state of the synchronised individuals” (p. 11).

One factor that has not yet received attention in the literature is the way in which variance in the task-demands required to perform a synchronised action relates to perceived cohesion. Not all coordinated behaviours are equal in terms of what is required of the coordinating individuals, so if a group’s collective actions are used to inform judgments about social dynamics, then we might expect activities that are perceived to be particularly difficult or exertive to serve as a cue that the members of the group are especially cohesive[1].

[1] We note that difficulty and exertion could be independent factors in the way they influence social dynamics. A difficult task such as a puzzle could conceivably be completed with little physical exertion and promote bonding through the shared experience and subsequent psychological consequences. A physically exertive task might trigger endorphin release which has been shown to be linked to prosociality (see Keller et al, 2014; Lang et al, 2017; Tarr, Launay & Dunbar, 2014). These issues are considered again in the General Discussion.

Indeed, recent work from a first-person perspective has found that groups actively engaging in collective exertive behaviours do experience elevated social bonding and that the effect of exertion on bonding is independent to that of behavioural synchrony (Davis, Taylor, & Cohen, 2015; Tarr, Launay, Cohen & Dunbar, 2015).

The primary aims of the current research are to investigate (1) whether perceived exertion is related to perceived social cohesion and (2) whether in-phase synchrony cues greater social cohesion compared to anti-phase synchrony (Experiment 1) and asynchronous phase-shifted movement (Experiment 2). In relation to aim (1), it is worth explaining what we mean by 'exertion'. This term may be most commonly interpreted as relating to physical demands, but we wish to use a broader definition that incorporates the physical and the non-physical. As such, we describe below a two-item measure that includes an item relating specifically to the physical challenge that an activity presents as well as an item that relates to the effort involved in successfully engaging in an activity (which can include non-physical effort, e.g. mental effort). As such, when we use the term 'exertion', it is this broad definition that we are referring to. We discuss this conceptualisation and its limits further in the General Discussion.

Our secondary aim is methodological. Studies on how behavioural synchrony influences social perception have utilised a number of different stimuli in their methodologies. Miles et al (2009) used animated stick-figures, while others have used both animated stick-figures (Lakens, 2010, Studies 1-3) and clips of actual people (Lakens, 2010 Study 4; Lakens & Stel, 2011). Ip, Chiu, and Wan (2006) used animated fictional creatures. All of these options have drawbacks. Using clips of real people risks introducing uncontrolled factors relating to the physical features of the people in the clips, whilst using animated figures may lack a degree of ecological validity.

One promising alternative is to utilise point-light figures (sometimes known as biological-motion figures; see Johansson, 1973). Point-light figures are stimuli that represent a human body engaged in movement by means of a small number of light points that move against a black background as if they were attached to major limb-joints. As experimental stimuli these allow for the testing of hypotheses relating to biological movement by removing all other potential social and structural cues. A rich literature exists on what information can be derived from such stimuli (for a review see Blake & Shiffrar, 2007) but generally it seems that our visual systems can extract socially relevant information from them, including emotion (Atkinson, Dittrich, Gemmell, & Young, 2004) and intention (Manera, Shouten, Becchio, Bara, & Verfaille, 2010). Using these stimuli to investigate the effect of synchronised movement on social cohesion follows in the Gestaltist tradition, most recently exemplified by work on perceptual grouping and how structure can be determined from motion cues (see, e.g., Dobbins & Grossman, 2018, who investigated the phenomenon whereby objects ambiguously rotating in depth tend to be seen as rotating synchronously).

In line with the foregoing, we set out to use point-light biological motion stimuli to investigate the effect of synchronised movement and perceived exertion on judgments of social cohesion.

Data and materials can be accessed at: https://osf.io/e4vfs/

Experiment 1

We predicted that point-light dyads displaying in-phase synchronisation would be rated as being more cohesive than those displaying anti-phase synchronisation (given in-phase synchrony's status as the global attractor state and its greater relative stability compared to anti-phase synchrony, and given the data in Macrae et al, 2008). We also hypothesised that ratings of exertion would predict ratings of cohesion.

Ethics

For both experiments described, ethical approval was granted through the institutional review process. All participants provided informed written consent and were provided with debriefing information when their participation was complete.

Design

A 4 (activity: walking; marching-on-the-spot; hip-rotations; star-jumps) x 2 (synchrony: in-phase; anti-phase) repeated measures design was employed in which participants viewed dyads performing the four activities in perfect synchrony (in-phase condition) and with synchrony shifted by 180° (anti-phase condition). Clips were rated on how socially cohesive the dyads were and the exertion required to perform the activity.

Stimuli and Apparatus

We used stimuli depicting a pair of point-light figures performing one of four physical actions side-by-side (see Figure 1 for an example). Three of these (marching on-the-spot, hip-rotations and star-jumps) were created specifically for this research using a Vicon T10 motion capture system running Vicon Nexus 1.8.5 software. To achieve this, one person was captured by the software performing the activity in time with a metronome set to 115bpm. We also used a "walking" point-light stimulus that is widely available online as an example of biological motion. This stimulus depicts a point-light figure walking on a treadmill, also at 115bpm. All stimuli had the light-points at the same anatomical locations. To create dyads, each original clip was copied and pasted using video-editing software so that the final clips displayed two identical point-light figures performing the action next to each other. The in-phase synchrony versions displayed each figure performing the action in perfect synchrony. The anti-phase version displayed the two figures performing the activity out-of-phase by 180°. This was achieved in the editing process by delaying the start of the playback of one figure compared to the other, such that the two figures deviated in their action cycle by 180° (i.e. when figure one was at the start of an action cycle, figure two was half-way through it). Delays were edited out to create the final clips of phase-shifted activity. All stimuli were 8s long.

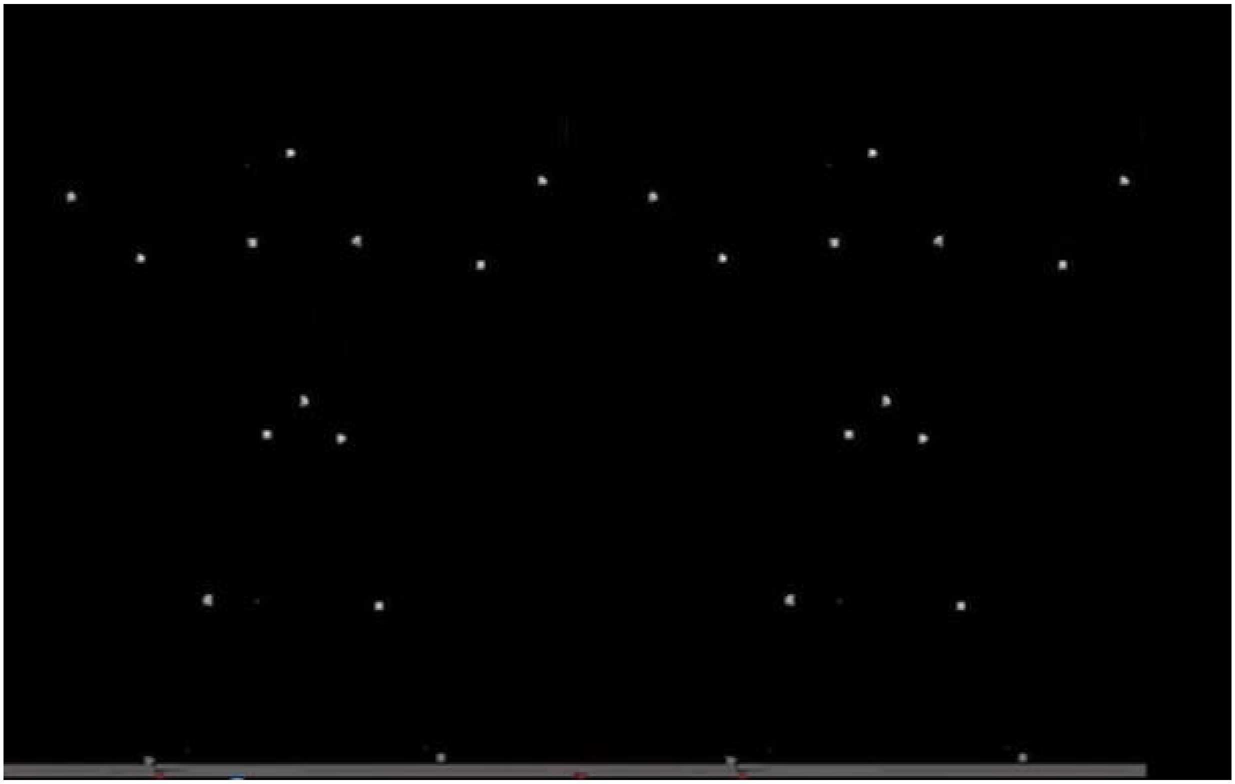

Figure 1. Still image of point-light dyad performing star-jumps synchronously

Stimuli pre-test

To ensure that the stimuli had the properties required, we first conducted a study to examine how the clips were rated for exertion. Clips were shown to forty-five people depicting a dyad performing each activity in synchrony. These were displayed in a random order and participants were asked to rate each one on a seven-point scale based on (1) how much effort was required to perform the action and (2) how physically challenging they considered each activity to be. These two ratings showed good internal consistency (Cronbach's $\alpha = .89$) and were subsequently used as a composite measure of exertion. Scores for each activity are shown in Figure 2.

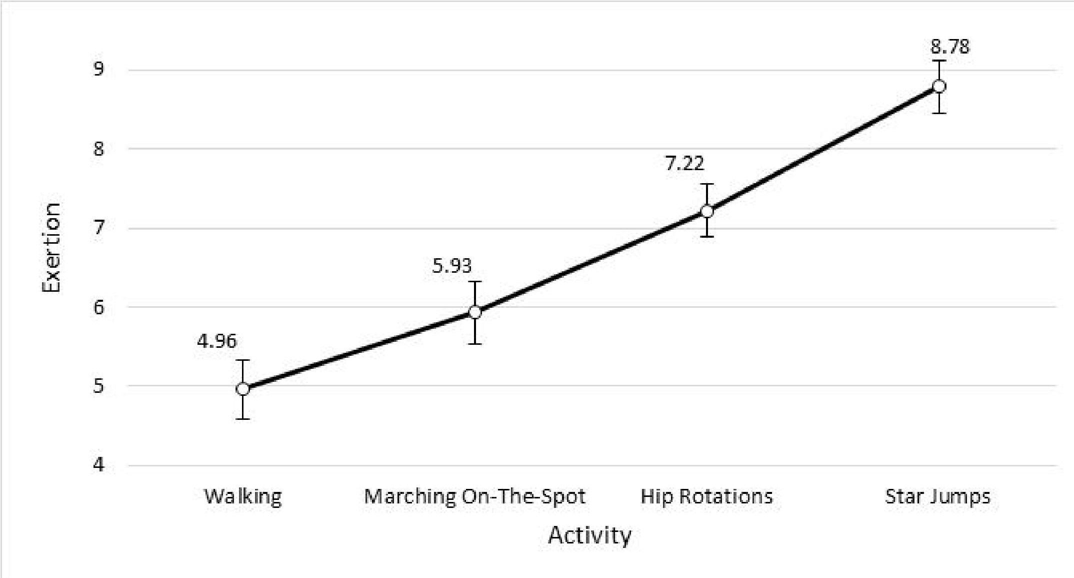

Figure 2. Summed exertion ratings for the four dyad activities (error bars represent standard error of the mean). Please note open y-axis.

Further analysis confirmed that all of the differences in exertion ratings between these four activities were statistically significant and so the stimuli were deemed suitable for our purposes.

Participants and Procedure

Participants were recruited through word-of-mouth, classroom/e-mail appeals and opportunity sampling. Participants were tested individually at isolated computer stations located in a psychology lab. At any one time there would be up to five participants in the lab, proceeding independently. Fifty-two participants (35 female; mean age 22) were first provided with an introduction to the field of social perception, including examples of how information about individuals can be obtained via the movement of point-light displays. After this demonstration they viewed point-light dyads perform each of the four activities twice, once in perfect synchrony (in-phase condition) and once with phase shifted by 180° (anti-phase condition). Clips were presented in a random order. After each clip, participants were asked to rate the dyad for social cohesion using a 10-item social cohesion measure (used previously in Wilson, Bassiou, Denli, Dolan and Watson, 2018). This measure uses a 7-point response scale and items were worded in the following way: “Based on the clip you have just watched, how much **trust** do you think exists between the two people?” (1 = *they do not trust each other at all*; to 7: *they trust each other completely*). Items included questions concerning: trust between the pair; the closeness of the relationship between the pair; levels of bonding; shared humour; camaraderie; friendship; rapport; cooperation; enjoyment of described activity; likelihood of collaborating in the future (definitions of camaraderie and rapport were provided alongside those terms). Again, participants were asked to rate each clip for how physically challenging they considered the activity to be to perform and how much effort they thought was required to perform the action. These items made up the composite exertion measure.

Results

The two items making up the exertion measure again showed good internal consistency (Cronbach’s $\alpha = .88$). The 10-item measure of cohesion also demonstrated good internal consistency (Cronbach’s $\alpha = .96$). A 4 (activity: walking, marching on-the-spot, hip-rotations, star-jumps) x 2 (synchrony: in-phase, anti-phase) repeated measures ANOVA was conducted on mean cohesion scores and composite exertion scores. For the cohesion ratings, the analysis revealed a main effect of activity: F (3, 153) = 16.59, $p < .001$, $\eta_p^2 = 0.245$; a main effect of synchrony: F (1, 51) = 46.96, $p < .001$, $\eta_p^2 = 0.479$ and a significant activity x synchrony interaction: F (3, 153) = 4.56, p = .004, η_p^2 = 0.082. Further analysis of the data revealed that the source of the interaction was the hip-rotation activity, which did not elicit different cohesion ratings between the two synchrony conditions (see Figure 3 and Discussion).

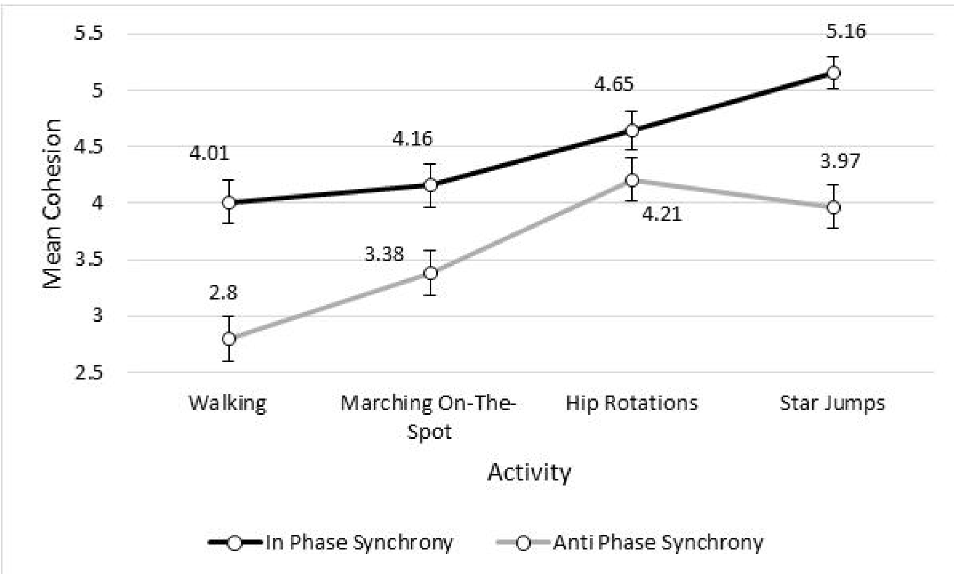

Figure 3. The mean cohesion ratings of Experiment 1 for four activities in two synchrony conditions. Error bars represent standard errors of the mean. Please note open y-axis.

To further investigate the relationship between exertion ratings and cohesion scores, we conducted regression analyses. We first ran a hierarchical multiple regression to assess the increase in variation explained by the addition of an interaction term between perceived exertion and synchrony condition to a main effects model. Synchrony condition (i.e. in-phase v anti-phase) was found to weakly moderate the effect of perceived exertion on perceived cohesion, as evidenced by a marginally significant increase in total variation explained of 0.7%: F (1, 412) = 4.147, p = .042, R^2 = .315, R^2_{Adjusted} = .310). To understand this interaction, simple slopes analyses were conducted. The first of these revealed that there was a statistically significant positive relationship between perceived cohesion and perceived exertion for the in-phase trials ($b = 0.188$, $SE = 0.028$, t (206) = 6.689, $p < .001$). The second of these also revealed a statistically significant positive relationship between perceived cohesion and perceived exertion for the anti-phase trials ($b = 0.270$, $SE = 0.029$, t (206) = 9.373, $p < .001$). Due to the potential anomaly presented by the hip-rotation condition (see the interaction in the ANOVA results described previously and the related discussion in the following section) we suspected that this condition may be influencing our results. We therefore removed all data from this condition and re-ran the hierarchical multiple regression. With the hip-rotation data removed, the interaction effect becomes non-significant, increasing the total variation explained by only 0.6%: F (1, 308) = 2.877, $p = .091$. These results suggest that ratings of exertion successfully predict perceived cohesion, and that this is generally true whether the synchronised activity is seen as being in-phase or anti-phase. We discuss the hip-rotation condition below.

Discussion for Experiment 1

In line with our hypothesis, we found that exertion ratings are a significant predictor of perceived social cohesion for dyads engaged in joint action. Furthermore, when the activities were seen to be in perfect synchrony (the in-phase condition) those engaged in them were generally perceived to have higher levels of social cohesion compared to when the same activities were seen performed with a 180° phase-shift (the anti-phase condition). This finding did not hold for the hip-rotation activity, however, and we explain this in the following way. When seen in the anti-phase version, the hip-rotation activity looks like two people cooperating to pass an object between them (one person turns to their right whilst at the same time the other turns to their left, resulting in the two briefly facing each other). If this interpretation of this stimulus is present in the population, then it likely resulted in elevated cohesion ratings for the anti-phase version, which appears to be the case from inspection of Figure 3. This finding lends support to Lakens & Stel's (2011) assertion that witnessing movement synchrony encourages inferences about the shared psychological state of those involved. Participants in Experiment 1 appear to have inferred cooperative intentions (which would imply social cohesion) from the anti-phase hip-rotation stimulus to an extent that was not possible from any of the other anti-phase activities.

Although generally supportive of our hypotheses, Experiment 1 is limited in how much it can tell us. As the data from the anti-phase hip-rotation condition demonstrate, anti-phase synchrony is still a kind of synchrony and is thus likely to be suggestive of social connectedness. Experiment 2 was conducted to compare the effects of perfect (in-phase) synchrony with dyads displaying asynchrony in their movements. We again hypothesise that exertion ratings will predict perceived cohesion and that dyads seen acting in synchrony will be rated as having higher levels of social cohesion compared to dyads seen acting asynchronously.

Experiment 2

Experiment 2 replicated the first experiment with one important difference. In this study four "asynchronous" phase-shift versions of each activity were created to compare with the in-phase synchrony condition.

Design

A 4 (activity: walking; marching-on-the-spot; hip-rotations; star-jumps) x 2 (synchrony: in-phase; asynchronous) x 4 (asynchrony phase-shift: 45°, 90°, 270° and 315°) mixed design was employed in which participants viewed dyads performing four activities in perfect synchrony and asynchronously. The phase-shift used in the asynchrony condition was the between-groups factor. Again, clips were rated on how socially cohesive the dyads were and the exertion required to perform the activity.

Stimuli, Participants and Procedure

Sixty participants took part (48 female; mean age: 25). We used the same four activities as the previous experiment. To create the asynchronous versions we again used video editing software to delay the playback of one of the pair so that the relative phase was out by 45°, 90°, 270° and 315°, creating four asynchronous versions of each activity. Again, delays were edited out and final clips were all 8s long. In all other respects, the procedure was identical to the previous experiment.

Results

The cohesion measure was again found to have good internal consistency (Cronbach's α = .97) as did the two-item measure of exertion (Cronbach's α = .82). A 4 (activity: walking, marching on-the-spot, hip-rotations, star-jumps) x 2 (synchrony: in-phase, asynchronous) x 4 (phase-shift: 45°, 90°, 270° and 315°) mixed ANOVA with phase-shift as the between-groups factor revealed significant main effects for synchrony: F (1, 56) = 36.07, p < .001, η_p^2 = 0.392 and for activity: F

(3, 168) = 8.456, $p < .001$, $\eta_p^2 = 0.131$ along with a significant interaction between activity and synchrony: F (3, 168) = 7.437, $p < .001$, $\eta_p^2 = 0.117$. The between-groups phase-shift factor revealed no main effect: F (3, 56) = 0.522, $p = .669$, $\eta_p^2 = 0.027$, demonstrating that the different phase-shifts that participants saw in the asynchronous condition were not a contributing factor. No significant interactions were found between activity and phase-shift: F (9, 168) = 0.903, $p = .524$, $\eta_p^2 = 0.046$ or between synchrony and phase-shift: F (3, 56) = 1.557, $p = .21$, $\eta_p^2 = 0.077$ and no three-way interaction was evident: F (9, 168) = 0.544, $p = .841$, $\eta_p^2 = 0.028$.

Further inspection revealed that the significant interaction was a consequence of the walking activity, which did not differ in perceived cohesion between the synchronous and asynchronous versions, in contrast to the other three activities (see Figure 4).

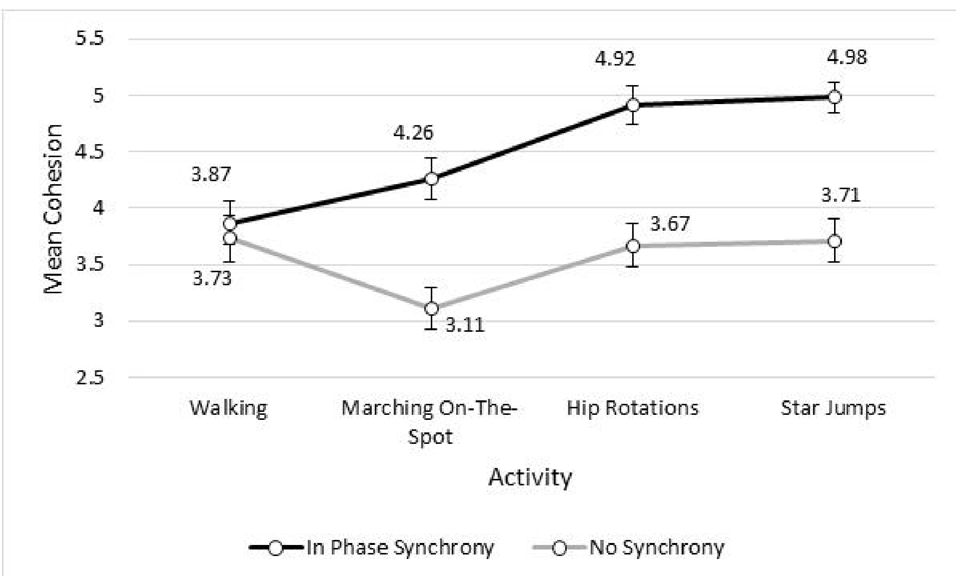

Figure 4. The mean cohesion ratings of Experiment 2 for four activities in two synchrony conditions. Error bars represent standard errors of the mean.

Again, to further investigate the relationship between exertion ratings and cohesion scores, we conducted regression analyses. Firstly, a hierarchical multiple regression was conducted to assess the increase in variation explained by the addition of an interaction term between perceived exertion and synchrony condition to a main effects model. This revealed that synchrony condition did not moderate the effect of perceived exertion on perceived cohesion, with the addition of the interaction term only increasing the total explained variance by 0.1%: F (1, 476) = 0.315, p =.575, R^2 = .223, R^2_{Adjusted} = .218. Given this, we subsequently removed the interaction term and ran a main-effects model. The model was able to account for 16.6% of the variance in cohesion scores: F (1, 478) = 94.849, p < .001, R^2 = .166, R^2_{Adjusted} = .164, with exertion ratings being a significant predictor of cohesion ratings: b = 0.203, SE = 0.021, t (478) = 9.739, p < .001.

Discussion for Experiment 2

The results from the second experiment support those from Experiment 1. Again, exertion ratings were able to predict ratings of social cohesion and, again, all but one of the activities demonstrated a clear difference in rated cohesion between the in-phase versions and the phase-shifted versions. Unlike the previous experiment, it was walking, not hip-rotation, that failed to show the expected difference. We offer potential explanations for this based on informal feedback from participants. There was some suggestion that the asynchronous versions of the walking activity looked more “natural” compared to the perfectly in-sync version, with one participant noting that the in-sync version looked “regimented, like they were doing it because they had to". Most people would certainly have had more experience witnessing pairs of individuals walking side-by-side than they would have had experience of witnessing pairs performing any of the other activities used as stimuli, and most dyads walking in the real world will naturally vary in their degree of synchrony during the course of the activity. As such, it is possible that we are particularly sensitive to this form of dyadic movement, meaning that any interpretation that the asynchronous walking stimuli were somehow more "natural" or "less forced" may have had an influence on cohesion scores that was not present for any of the other (less familiar and less common) activities (see also Wilson et al, 2018, for data on why collective walking might be considered a unique social activity that is associated with elevated social cohesion).

The cohesion scores in the hip-rotation condition show the expected difference between synchronous and asynchronous versions, in contrast to the previous experiment. We explained the failure to find this difference in Experiment 1 by suggesting that the 180° phase-shift made the activity appear cooperative, with one person turning to the right to hand something to other person who is turning to the left to receive it. In Experiment 2 the phase manipulations made the relative positions of the point-light figures look less like they might be cooperating, and this is reflected in the cohesion ratings in the asynchronous condition, which are lower than that of the anti-phase condition in Experiment 1, supporting our explanation and providing further evidence for our initial hypothesis.

General Discussion

The current research was concerned with how observing synchronised activity influences judgments of social cohesion. We also wanted to investigate the role of perceived exertion, which is something that has not yet been addressed in the social perception literature. Our first experiment demonstrated that in-phase synchrony is generally perceived to be associated with higher levels of social cohesion compared to anti-phase synchrony, and that perceived exertion was a good predictor of cohesion ratings. In-phase synchrony (when the behaviours are perfectly matched) is considered to be a relatively more stable mode of coordination compared to anti-phase synchrony (when the behaviours are phase-shifted by 180°; see Haken, Kelso & Bunz, 1985) and the primacy of this mode of coordination as a cue to social cohesion was evident in all but one of the activities we used as stimuli in the first experiment.

The activity that failed to elicit differences in cohesion ratings between the two conditions was the hip-rotation activity. This finding is potentially important, as it tells us that participants were not solely using the movements they perceived to guide their judgments. Instead, it seems that they were also sensitive to other indications of coordination. The hip-rotation activity seen in its anti-phase version looked like two people coordinating their behaviour to pass something between them, which accounts for the elevated cohesion scores seen for this activity. This is in line with Lakens & Stel's (2011) conclusion that the effects of movement synchrony on social judgments are not purely perceptual, and are mediated by inferences about the intentions of those observed acting in synchrony. To their conclusion we would add that not all forms of synchrony are equivalent when used to make social judgments. Compared to in-phase synchrony, anti-phase synchrony (which is still synchronous behaviour) appears to be utilised more cautiously as a social cue, requiring an interpretation relating to it serving a functional purpose. This finding also suggests an avenue for future research given that many coordinated actions between individuals do not necessarily require strict behavioural synchrony. For example, for some coordinated behaviours anti-phase synchrony may be more conducive to success (see, e.g. Lang et al, 2016). Future research should investigate (1) whether similar effects are present when point-light figures are viewed engaging in coordinated acts that do not involve close synchronisation, and (2) under what circumstances anti-phase synchronisation requires interpretation before it is seen as an indication of social dynamics.

Experiment 2 was similarly informative. Again, we found that perceived exertion predicted cohesion ratings and again we found that in-phase synchrony was generally associated with greater levels of perceived social cohesion compared to phase-shifted asynchronous versions of the paired activities. The one exception to this was in the walking condition. This may have been a consequence of participants' familiarity with this activity compared to the other activities, an explanation derived from informal comments indicating that the asynchronous versions of this activity looked more "natural". Alternatively, walking as an activity may be seen to involve more social cohesion due to its status as a form of collective directional movement (see Wilson et al, 2018, although this explanation does not account for the lack of difference found between the two synchrony conditions for this activity in Experiment 1). This finding further supports the assertion that participants do not rely purely on perceptual features when making social judgments.

The finding that perceived exertion predicts ratings of cohesion suggests another dimension by which coordinated behaviours are assessed. This makes sense given the common-sense intuition that closely coordinated actions are effortful. One question for future research to address is the exact nature of the relationship between perceived exertion and perceived synchrony. Does perfect synchrony always imply high exertion or are there mediating factors? Could the effects of synchrony and perceived exertion on ratings of social closeness be multiplicative? How does variance in perceived exertion influence the inferences that observers make about the intentions of those observed? Furthermore, our broad conceptualisation of exertion may not hold true for all activities. While the Cronbach's alpha scores justify our use of the combined measure, we acknowledge that the two items could conceivably be indexing different things (one relating explicitly to physical task demands and the other relating to non-physical task demands). Given the nature of our stimulus materials, it is perhaps not surprising that we found a relationship between these two items, but it is easy to imagine other stimuli in which a clearer delineation exists between physical and non-physical task demands. Indeed, the data from the hip-rotation activity (Experiment 1) and the walking activity (Experiment 2) suggest that perceptions of social dynamics are a function of both physical and non-physical aspects of the tasks. Future research is required to fully tease apart the different components of perceived exertion and how these relate to social judgments.

Our secondary objective was to explore point-light stimuli as a way of investigating perceptions of social cohesion, and our results demonstrate that people can quite easily extract information about social relationships from such images. This is in line with an impressive literature on what can be extracted from biological motion cues (see Blake & Shiffrar, 2007) and supports the notion that inferring meaning from movement is one of the most important functions of our perceptual equipment. Our use of dyads raises the question of whether perceiving larger collections of synchronised individuals would result in similar findings. Mogan et al (2017) report meta-analytic data suggesting that perceived social bonding in synchronised groups is not moderated by group size, but it is an empirical question as to whether this holds true for other forms of co-ordinated (but not necessarily synchronised) activities.

Our research is not without limitations. Firstly, it is not clear whether our results would hold when actual people were seen rather than point-light figures. The motivation behind our choosing this form of stimuli was to minimise as much as possible any other structural and social cues that could influence the relevant ratings. However, just as previous research using animated figures may lack ecological validity, so our use of point-light displays might be open to similar criticisms. Further research is needed on whether our findings apply to stimuli more closely resembling actual people. Linked to this is our choice of activities. In order to manipulate perceived exertion, we chose to have our dyads engage in activities that varied in their physical demands. As a consequence, the activities increasingly looked like forms of exercise (especially the star-jumps activity). If participants were conceptualising some of the activities in this way, then this could potentially be a confounding factor. Future research should incorporate a wider range of activities to be assessed. We also note potential issues with statistical power, particularly in Experiment 2, which incorporated a number of manipulations. Notably, the between-groups manipulation in this experiment (phase-shift version) had four levels across 60 participants. Although we report this as being non-significant, it is worth pointing out that this analysis was associated with a power of 0.15 raising the possibility of a Type 2 error. All of these issues should be taken into account in future studies.

The capacity for individuals to synchronise their actions involves an array of psychological and physiological mechanisms and could be considered to be a core component of human sociality (Launay, Tarr, & Dunbar, 2016; Marsh, Richardson, & Schmidt, 2009). Given this, it should not be surprising that our perceptual systems appear especially sensitive to it. What our results suggest (along with the results of many other studies) is that this intuition is deeply ingrained into our mental systems, including those dealing with perception (as the original Gestaltists suggested) and those dealing with social/interpersonal dynamics. When independent elements of the physical or social world act in synchrony, this is usually telling us something. What cognitive scientists consistently find is that processing systems involved in gathering information from the environment seem to be particularly sensitive to this kind of information. Our results support this, but our two interactions also suggest that at the social level other factors come into play. Synchronised behaviour is informative, but when people see it they often make inferences about the *intentions* behind the synchrony. Future research should investigate this further. Are the soldiers in those highly synchronised marching units *really* as cohesive as their commanders or generals might want us to think?

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